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Study of Formation Mechanisms of Photo-Induced Dichroism in Azo-Containing Polymer Films

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Abstract—Photoinduced dichroism (PD) in azo-containing polymers can result from chromophore orientation and/or cis-isomer accumulation. The PD formation mechanism of azochrommophores DO3 (DisperseOrange 3) doped in polymethyl methacrylate (PMMA) at a temperature varying from −20 to +120 °C is studied by UV-visible spectroscopy. It is shown that the main PD formation mechanism at $T < 0$ °C and $T > 60$ °C is cis-isomer accumulation and trans-isomer photoorientation, respectively.

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Introduction. The chromophore exposed to polarized light absorbs a light photon with the probability $\sim\cos^2\theta$, where θ is the angle between the field polarization direction and the dipole moment μ of the optical transition in the molecule (Fig. 1) [1, 2].

As a result of absorption, the chromophore transforms from trans- to cis-conformation. Depending on temperature, the further behavior of molecules can be different.

(i) If the reverse cis-trans transition is possible, the molecule is reoriented in the direction perpendicular to pump field polarization due to multiple trans-cis-trans isomerization cycles [3–5].

(ii) But if the energy is insufficient for the cis-trans transition, chromophores are accumulated in the cis-form [2].

Both effects give rise to optical anisotropy. Anisotropic media are widely used in photonics and optoelectronics [6–8]. Understanding of photoinduced processes in azo-containing polymers is an important problem. The objective of this work is to study the formation mechanisms of photoinduced dichroism in polymers doped with chromophores in a wide temperature range.

Experimental. Photoinduced dichroism was studied using polymethyl methacrylate (PMMA) films doped with 4-amino-4′-nitroazobenzol chromophores (DO3, Fig. 2).

Films were prepared from a 10% PMMA solution in acetone with added ∼3% of chromophore. The solution was applied on a KBr substrate, and films were annealed at a temperature of 120 °C

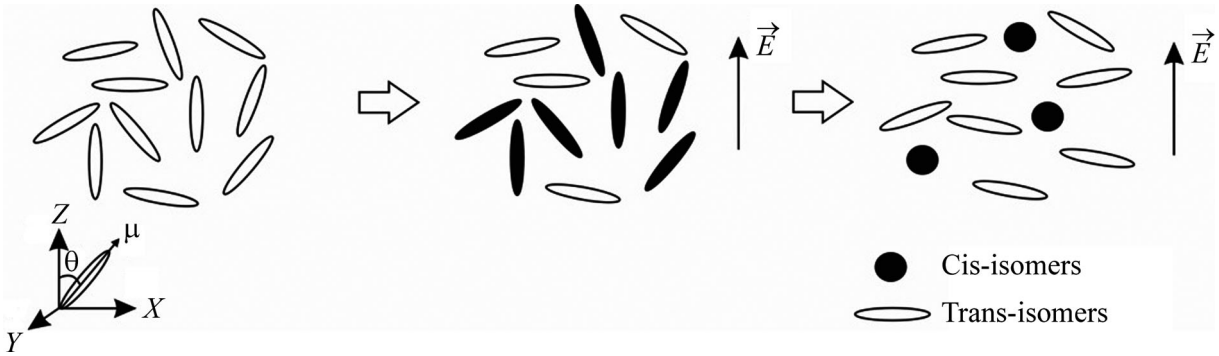

Fig. 1. Chromophore photoselection in a linearly polarized field.